

# ON THE OCCURRENCE OF SCHIZOGONY IN AN AVIAN LEUCOCYTOZOÖN, *L. LOVATI*, PARASITIC IN THE RED GROUSE, *LAGOPUS SCOTICUS*

BY

H. B. FANTHAM, D.Sc. (LOND.), B.A. (CANTAB.), A.R.C.S.,  
CHRIST'S COLLEGE, CAMBRIDGE, AND LIVERPOOL SCHOOL OF  
TROPICAL MEDICINE

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## PLATE XXI

Although the Parasitic Protoza are much studied at present, there is no doubt that more facts are required about the life-cycle of many parasites of whose history certain stages are well known. Among such parasites are the avian *Leucocytozoa*.

During the past two years I have spent some of my time as Protozoologist to the Grouse Disease Inquiry, in the investigation of the Protozoa parasitic in the grouse. One, at least, of the protozoal parasites of the grouse, *Eimeria (Coccidium) avium*, is the cause of a rapid and fatal disease among grouse chicks. Among the parasites present in some apparently healthy grouse was a *Leucocytozoön*, *L. lovati*, first recorded by Seligmann and Sambon in a short note in 1907. My investigation of *L. lovati* led to the elucidation of another phase (schizogony) in its life history.

The host cells of the avian *Leucocytozoa* may be either mononuclear leucocytes or erythroblasts, or both. The exact nature of the host cell of *Leucocytozoa*, which is somewhat controversial, will not be discussed in this paper. Concerning the *Leucocytozoa* themselves, gametocytes, both male and female, have been described from the blood of the host. The male gametocyte of *L. lovati* (Pl. XXI, fig. 1) possesses hyaline, pale-staining cytoplasm, and a rather large nucleus containing a number of chromatin granules. The female gametocyte (fig. 2) has a deeply staining granular and

somewhat alveolar cytoplasm, with a central nucleus containing a karyosome. The exact delimitation of the nucleus of a *Leucocytozoon* within its host cell is often difficult.

In the specimens of *L. lovati* that I examined, the microgametocytes were found to measure from  $13\mu$  to  $17\mu$  by  $6\mu$  to  $12\mu$ , while the macrogametocytes were  $14\mu$  to  $20\mu$  by  $10\mu$  to  $16\mu$ .

Till recently, the gametocytes and gametes only of avian *Leucocytozoa* were known. However, parasites somewhat intermediate in type between the male and female gametocytes occur, though such intermediate forms are not at all common in the peripheral blood of the host. The intermediate forms in the case of *L. lovati* may be seen in the blood of the spleen of the grouse, though they may be easily overlooked.

In the summer of 1909, I examined two fresh grouse in whose peripheral and heart blood living *Leucocytozoa* were seen. The internal organs were immediately examined after the death of the birds. In stained preparations of the spleens of the two birds, small vermicular forms were encountered, both free and just entered into their host cells. Careful search showed that in the spleen were many full-grown *Leucocytozoa*, some of which exhibited no very definite sexual differentiation. While the gametocytes encountered in the blood often produced marked elongation of the host cells, the deformation in the case of the special splenic forms was slight (fig. 3), and the host cells seemed almost entirely absorbed (fig. 4). These parasites are the schizonts, which are slightly smaller than the gametocytes, and measure  $11\mu$  to  $14\mu$  by  $8\mu$  to  $11\mu$ . The cytoplasm of the oval schizonts becomes somewhat concentrated while they are uninucleate (fig. 4). The character of the nucleus of the schizont approaches that of the microgametocyte, while the general cytoplasm resembles that of the macrogametocyte, but differs from it in being less alveolar and possessing smaller granules.

Nuclear multiplication occurs, apparently, by a series of rapid binary fissions, and the daughter nuclei, some of which may remain united (fig. 5) for a short time, ultimately migrate towards the periphery. Segmentation of the cytoplasm around the small nuclei occurs (fig. 6), and the result is that some twelve to twenty merozoites (fig. 7) are produced. Each merozoite is a small, vermicular, somewhat curved organism, capable of active movement. The merozoites measure  $7\mu$

to  $8\mu$  by  $1\mu$  to  $1.5\mu$ . Some residual protoplasm is found in the remains of the schizont after the merozoite formation is completed. The merozoites escape (fig. 8) from the tenuous envelope of the schizont and become free-living forms (fig. 9) in the blood of the spleen. But their free stage of existence is of short duration. Leucocytes or immature erythrocytes are encountered, and the young merozoites penetrate the host cells and enter upon the trophic phase of their existence, ultimately differentiating either as sexual individuals or as schizonts.

The occurrence of schizogony in *L. lovati* is very difficult to demonstrate. Though many infected birds may be examined, schizogony may not be detected, for the period of schizogony may not be attained, and also this form of multiplication is passed through with remarkable rapidity, so that merozoites may be formed and dispersed before the investigator has had time to examine the material available. Rapidity of schizogony is also found in such parasites as *Coccidia*, where often it is not easy to obtain preparations exhibiting schizogony, while some gametocytes can usually be obtained in any preparation from an infected host. In connection with schizogony of *Leucocytozoa*, great interest attaches to the discovery of Mathis and Léger of periodic increases in the number of the gametocytes of *L. caulleryi* in the peripheral blood of its host, the domestic fowl of Tonkin, for which increase no explanation has hitherto been afforded. It seems to me that during the intervals between successive crops of parasites, asexual multiplication probably occurs. As in *L. lovati* schizogony occurs in an internal organ, namely, the spleen, it is suggestive that a similar condition prevails in *L. caulleryi*; and as in other Protozoa, the schizogony culminates in sexual differentiation, so in *L. caulleryi* it seems likely that a similar sequence may occur.

It may be added that preparations of bone marrow of the infected birds did not furnish schizonts, though it is possible that schizogony might be found to occur therein, if abundance of material were available for research. *L. lovati* did not appear to be very harmful to the grouse investigated, and in the two cases in which schizogony occurred, no other protozoan parasite was present in the blood of the grouse, all of whose organs were minutely examined.

*L. lovati* may be transmitted from grouse to grouse by the agency of the grouse-fly, *Ornithomyia lagopodis*, for vermicules devoid of

melanin pigment have been found in the gut of the fly. But, as with most blood parasites, further work is necessary with regard to the exact mode of transmission of protozoal parasites from host to host.

The avian *Leucocytozoa*, as exemplified by *L. lovati*, in which schizogony is now shown to occur, are, then, typical members of the *Haemosporidia*, allied to the malarial parasites.

In conclusion, while the method of schizogony in *L. lovati* is as indicated in this paper, it does not follow that the multiplicative processes of all avian *Leucocytozoa* are on the same lines, though I think that it is probable that in all these avian blood parasites, the period of schizogony is a short one, and that much patient investigation under the most varied conditions will be necessary to establish schizogony in most members of the avian *Leucocytozoa*.

#### LITERATURE

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## EXPLANATION OF PLATE XXI

The figures are slightly diagrammatic. Magnification of figs. 1 and 2 about 1,800 diameters; of figs. 3 to 9 about 2,000 diameters.

Figs. 1 and 2. Diagrams of male and female gametocytes of *Leucocytozoon lovati*. The male gametocyte (fig. 1) is usually slightly smaller than the female (fig. 2), and its cytoplasm is hyaline. Chromatoid granules often occur at the ends of the oval or round parasites. The host cell has become spindle-shaped in each case, with its nucleus pushed to one side by the parasite.

Figs. 3 to 9. Diagrams of schizogony of *Leucocytozoon lovati*, as seen in smears of the spleen of the avian host.

Fig. 3. Schizont, with remains of the host cell at either pole and host-cell nucleus to one side.

Fig. 4. Uninucleate schizont, with host cell almost entirely absorbed except for slight remains of the host-cell nucleus to one side.

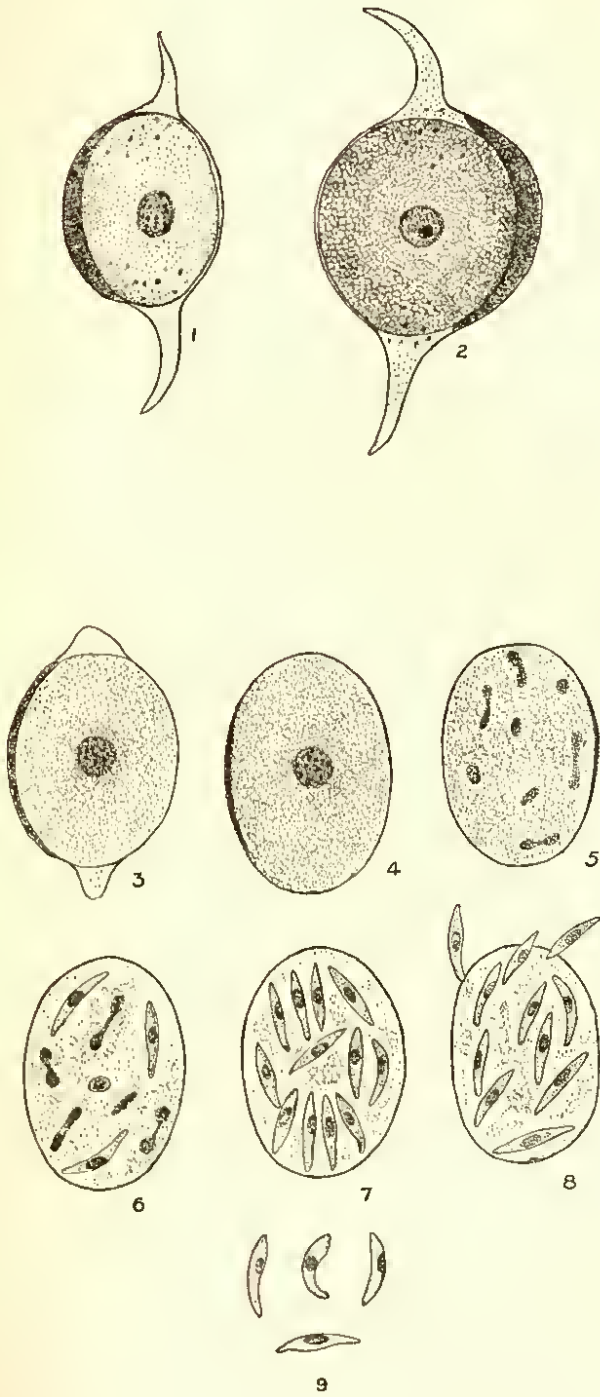
Fig. 5. Schizont, showing nuclear multiplication. Very slight remains of host-cell nucleus on the right side.

Fig. 6. Schizont in process of formation of merozoites.

Fig. 7. Schizont showing merozoites differentiated within.

Fig. 8. Merozoites beginning to escape from schizont.

Fig. 9. Group of free merozoites.



SCHIZOGONY OF LEUCOCYTOZOOM LOVATI.